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# THE USE OF ILLUSTRATIVE MATERIAL IN TEACHING AGRICULTURE IN RURAL SCHOOLS.

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# THE USE OF ILLUSTRATIVE MATERIAL IN TEACHING AGRICULTURE IN RURAL SCHOOLS.

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## AGRICULTURE IN RURAL SCHOOLS.

The value of agriculture as a subject of study in the rural schools will be determined largely by the attitude of teachers toward it. In the high school and the consolidated rural school employing three or more teachers, the problem of teaching agriculture successfully is not a difficult one, for in such schools the facilities for illustrating the work are better than in the smaller schools, and there, too, a teacher having training in agriculture can be employed to teach agriculture and the other sciences. Even in the one-room rural school the difficulties, while they are more numerous, are far from being insurmountable. In such schools, it is true, teachers with a college education or with special training in agriculture are seldom found, and teachers having sufficient originality and energy to free themselves from a condition of absolute dependence upon the text-book soon command good salaries in other positions or take up some independent occupation. And yet these same rural schools, with their scanty equipment and poorly paid, poorly trained teachers, go on year after year turning out strong young men who, in spite of inefficient schooling, have acquired an education which enables them to forge to the front in the business or professional world, or to rise to high places in the councils of the Nation. Training for efficiency seems to be acquired in some way through mere contact with the environment of the rural school, or more likely through participation in the varied business operations and work of country life. How better to utilize these undefined and almost intangible educational forces is the question which prominent educators are now trying to solve by introducing nature study and elementary agriculture into the rural schools. The great danger is that agriculture, when it is introduced into these schools, will be treated merely as an additional burden to the teacher, as a text-book subject pure and simple; that the teacher will fail to see and appreciate the great wealth of illustrative material lying all around, which, if properly employed, would make the study of agriculture one of the most valuable subjects in the country school curriculum. The point of view for the teacher is quite clearly indicated in a recent

lecture by L. H. Bailey on "The School of the Future,"[a] in which he says:

> In an agricultural community, for example, all the farms of the neighborhood will afford training in the elements of failure and success. There is no reason why the pupils should not know why and how a man succeeds with his orchard or dairy or factory, as well as to have the cyclopedia information about the names of capes and mountains, dates, and the like; and why should not every good farmer explain his operations to the pupils? Such work, if well done, would vitalize the school and lift it clean out of the ruts of tradition and custom. It would make a wholly new enterprise of the school, rendering it as broad and significant and native as the community itself, not a puny exotic effort for some reason dropped down in the neighborhood. When the public schools begin to touch experience and pursuits in a perfectly frank and natural way, we hope that persons who have money to give for education will bestow some of it on elementary and country schools, where it will reach the very springs of life.

There is no good reason why the teacher should not draw upon "all the farms of the neighborhood," all the highways, all the buildings, and many of the markets and business houses of the near-by towns for illustrative material to aid in teaching agriculture in the public school. The intrinsic value of this material is so great that few colleges would be able to purchase it, and yet it is available for the free use of the public schools. It is for the purpose of suggesting the nature of this material and how it may be used that this article is prepared. As a basis for further suggestions let us first see what use some schools are now making of relatively inexpensive illustrative materials in teaching agriculture, and how this teaching is made useful to the whole community.

## AGRICULTURE AS TAUGHT IN SOME PUBLIC SCHOOLS.

### A CONSOLIDATED SCHOOL.

In east Tennessee, near Concord, is a school which was organized by the consolidation of three school districts, and named the Farragut School in honor of the great naval hero, whose supposed birthplace is about half a mile away. One of the old schoolhouses was abandoned, one was moved to the site of the new school and remodeled for laboratory work in domestic science and manual training, and the other is still used for school purposes by the children of the primary grades in the village of Concord. The new school was opened in September, 1904, and is supported jointly by the Southern Education Board, which had contributed up to July 1, 1905, about $3,500; the State tax levy for the salaries of teachers, and local funds raised by means of subscriptions and entertainments. The funds thus raised, exclusive of teachers' wages, amounted, July 1, 1905, to about $8,000, of which $6,000 was expended for a seven-room school building and equipment, and $620 for 12½ acres of land. A small poultry house, with incuba-

[a] The Outlook to Nature. The Macmillan Company.

tor and brooder, a two-frame hotbed, and a shed for horses comprise the major portion of the farm equipment. Two other buildings are planned, a small barn and a dwelling house, which will enable the teacher of agriculture to live at the school. There are at present five teachers, including the superintendent and the teacher of agriculture, the latter an agricultural college graduate.

It is the plan to make this a model rural school in which agriculture, domestic science, and manual training shall be leading features, and in the single year of its operation much progress in this direction has been made, especially in the agricultural work. In the first place, a very creditable start has been made in assembling an agricultural

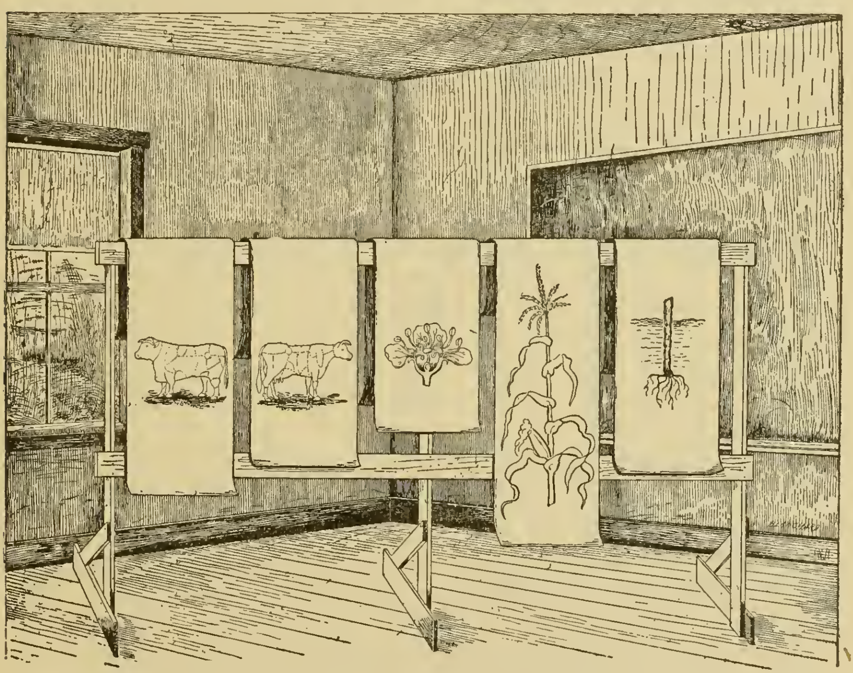

FIG. 70.—A frame for homemade manila charts used at the Farragut School, Concord, Tenn.

library. This consists of a number of elementary text-books of agriculture, which are used as reference works in connection with the regular text-book; a collection of bulletins from this Department and from State experiment stations; Yearbooks of this Department, and a large number of agricultural papers, about 40 of which are received regularly through the courtesy of the publishers. These books and other publications are kept in the agricultural class room, which also serves as a reading room and agricultural laboratory. Numerous homemade manila paper charts tacked to a rough frame, about 12 feet long and 5 feet high (fig. 70), are used in illustrating lectures on any

subject which can not be illustrated better in some other way. A large number of charts can be fastened to one frame, and those which are in front of the chart to be used can be turned over back.

Instruction in agriculture is given by means of text-books, lectures, a limited amount of laboratory work, and outdoor work. The last named is of most interest in this connection.

Of the land belonging to the Farragut School 6 acres is devoted to field crops, 3 acres to horticulture, and 3½ acres to campus and farm-yard. The field-crop work has consisted largely of variety tests and demonstration work, and has been nearly self-sustaining. The teacher of agriculture writes that in a wheat experiment with three plats of about 1 acre each they succeeded in demonstrating the "value of seed selection, treatment for smut, balanced fertilization, and variety," besides learning something concerning the diseases and enemies of wheat, "and the yield paid for it all." Potatoes, onions, corn, and tomatoes were handled in the same way and quite as successfully. This work was of value not only to the pupils in the school, but also to the farmers of the whole community, who watched the experiments with a great deal of interest.

In connection with the field work the class in agriculture has recently taken up the study of farm drainage, hillside ditching, and contour work, and has taken sufficient interest in this work to raise the necessary funds for the purchase of a farm level (exercise 1). A milk tester has also been purchased and the pupils are testing milk from cows in different dairy herds, which are numerous in this beautiful east Tennessee valley.

A small plat of alfalfa grown on the school farm has aroused considerable interest among the farmers and led to the sowing of alfalfa in the neighborhood.

The hotbed furnishes material for instruction, is a source of income to the school, and a convenience to the farmers of the district. The students are taught how to make and manage hotbeds. All the early garden plants and flowers needed for transplanting last spring were raised in this one small hotbed, and $10 worth of tomato plants were sold to farmers who preferred paying a small price for such plants to undertaking the propagation of them in pans or boxes in the house.

The poultry work is also attracting attention. The poultry consists of two small flocks of pure-bred Brown Leghorns and Barred Plymouth Rocks, of which careful records as to feed, laying qualities, etc., are kept. Forty-five incubator chicks were sold as broilers, but all the choicer birds are disposed of for breeding purposes at $1 each, which the teacher of agriculture speaks of as "an unheard-of price heretofore."

Exercise 1.—*To make a farm-level.*

A cheap but serviceable farm-level can be made as shown in figure 71. It should be 4 or 5 feet high, with a crossbar about 3 feet long. Small glass tubes are tied to the ends of the crossbar and connected by a piece of rubber tubing 4 or 5 feet long. The tubing is filled with water (colored water is better) up to the line A B. When the instrument is set so that the line A B exactly corresponds with the upper edge of

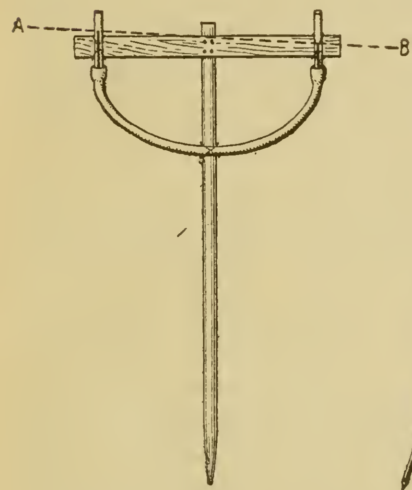


Fig. 71.—A homemade farm-level.

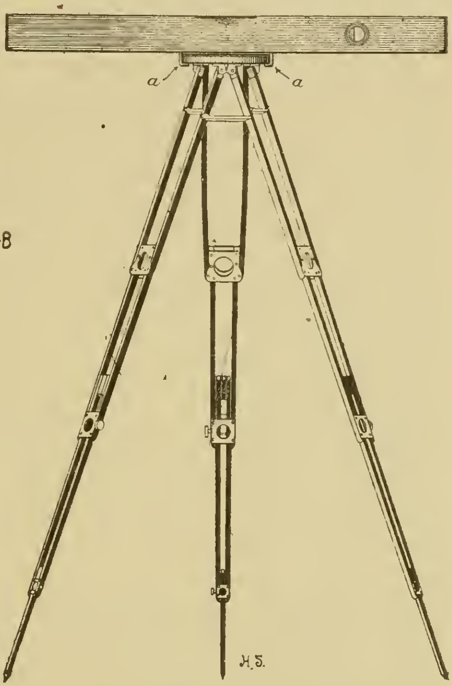


Fig. 72.—A farm-level made with tripod and carpenter's level.

the crossbar, the latter will be level. Such an instrument will cost not over 50 cents, and will be as accurate and nearly as convenient as a farm-level costing $15 to $25.

A more convenient farm-level can be made by fastening a 30-inch carpenter's level, costing about $1.25, to the head of an ordinary camera tripod. Make the fastening by means of two right-angled screw hooks, as shown at *a* in figure 72.

Here, then, is a rural school started as an experiment in adapting school work to country-life conditions. It has good equipment in buildings and land, rather expensive as country schools go, but not beyond the means of any consolidated district embracing within its territory from 20 to 30 square miles of well-improved farm land. It has had financial assistance from outside, but even that would have been unnecessary if the people of the three original school districts could have foreseen the possible advantages of a consolidated agricultural school in better courses of study, more efficient instruction, longer school year, and increased valuation of farm property. During the first year the attendance was considerably greater than the previous combined attendance in the three small schools. This is accounted

for by the fact that many boys attended the consolidated school who had outgrown the district school and gone to work and who either could not go to village or city high schools or were sensitive about going into classes with pupils much younger than themselves. These boys have given emphatic indorsement to the new order of things.

### A VILLAGE HIGH SCHOOL.

In Erie County, Pa., surrounded by a good general farming and dairy country, is the village of Waterford, on the outskirts of which is the site of Fort Le Bœuf, of French and Indian war fame. At Waterford the first school in Erie County was established in 1800, and here in 1822 was erected a stone academy building, which is used to-day as the main part of the high-school building. The township of Waterford has a population of 1,460, and about half of these (770) reside in the borough of Waterford. The borough has its own elementary school, but the high school is supported and controlled jointly by the borough and township.

This high school, with its three teachers and three courses of study (language, scientific, and agricultural), has an enrollment of 80 pupils, and 35 of these are in the agricultural course. This course includes agriculture, five hours a week for four years. The work of the first year is devoted to a study of plant life—germination, plant growth, plant food, reproduction, propagation, transplanting, pruning, and uses of plants; the second year to a study of field, orchard, and garden crops; the third year to domestic animals, dairying, and soil physics, and the fourth year to the chemistry of soils and of plant and animal life. Text-books are used in the class room; a small library of agricultural reference books, reports and bulletins of this Department and experiment stations, and agricultural papers contributed by the publishers is in almost constant use, and lectures on agricultural subjects are given before the class and before the whole school by the instructor in agriculture, who is an agricultural college graduate. But the feature of instruction which chiefly distinguishes this agricultural course from the ordinary high-school course is the prominence given to the laboratory work and the outdoor practicum. For the laboratory work there is no elaborate apparatus. The pupils make much of their own apparatus, furnish their own reagent bottles, and, moreover, use them. In the plant-life course the pupils study not elaborate and carefully prepared drawings, but the plants themselves with reference to their life history and economic uses (Pl. XIV, fig. 1).

For the outdoor practicum the school is unfortunate in having neither land nor domestic animals or fowls, and yet it has a wealth of illustrative material all around it. Every good farm within a radius of 3 or 4 miles, nearly every barn and poultry yard in the village, the butcher shops, and the farm implement stores furnish costly

illustrative material and extend vastly the teaching force of the high school. The farmers and other owners of good live stock either bring their animals to the door of the school house to be studied by the class in agriculture (Pl. XIV, fig. 2), or allow the class to go to their barns and fields for this purpose (Pl. XV, fig. 1). It is said to be a rare thing for a good horse to come to the village and get away without being examined by the high-school class in animal husbandry.

The writer was fortunate in being the guest of the school one day last October and in having an opportunity to listen to some of the recitations in agriculture. A class of 14 boys and 6 girls was studying animal husbandry. It had been organized only three or four weeks, and yet the interest manifested and the readiness with which the boys and girls described the beef type, the dairy type, and various breeds of cattle, the mutton and wool types of sheep, the principal breeds of draft horses, and some of the standard-bred roadsters and trotters, were indeed surprising. At the close of the recitation the class was taken to a barn in the village, where several fine roadsters were owned. The owner was not at home, but the teacher had standing permission to take the horses from the barn in order that the class might examine them. A fine Hambletonian mare (Pl. XV, fig. 2) was led into the yard and examined critically by the pupils and criticised by them, the different points being brought out by skillful questioning on the part of the teacher.

From this place the class went to a livery barn where a splendid black Percheron stallion was stabled for the day. A member of the class had discovered the horse as he was being driven in from another town 14 miles away, and following the driver to the barn had got permission for the class to examine him. When the livery barn was reached the driver brought his stallion out into the street, put him through his paces, helped the teacher in calling attention to his good points and the contrasts between the draft type and the roadster type of horses, and allowed us to take several photographs. It was an instructive lesson not only for the members of the agricultural class, but for the score or more of farmers and townsmen who collected around the livery stable. In much the same way the local butcher is an instructor in the high school. The class studying the beef type of cattle, or the mutton sheep, or the different classes of swine is taken to the butcher shop and given a demonstration lesson on cuts and their relative values, which of the breeds are apt to produce the better cuts, which the better quality, and so on.

Thus this little village high school, though it pays only $2,230 a year in salaries and only $370 for other expenses, has a faculty made up of numerous specialists and an equipment in illustrative material such as few technical high schools could afford. And the pupils are being trained in the "elements of failure and success," not only on

"all the farms of the neighborhood," but in the village shops and markets. This is training for efficiency. It is training for culture, for breadth of view, and for sympathy with all that goes to make up the life of the community.

### A COUNTY HIGH SCHOOL.

Kansas has local option in the establishment of county high schools. As a result several sparsely settled counties or counties in which there are few large towns are supporting such schools. Norton County, which a few years ago was dotted with sod school houses (Pl. XVI, fig. 1), and which still has many sod dwelling houses, now supports a good county high school in the village of Norton, a town of about 1,500 inhabitants, located near the geographical center of the county. The high-school building (Pl. XVI, fig. 2) is of brick, 2 stories high, over a well-lighted basement, and is located on the outskirts of the village, where land can be easily secured. The basement contains furnace and fuel rooms, lavatories, and a gymnasium. On the first floor is a physics and chemistry room, a natural history room, a music and art room, and the rooms of the business department. The second floor contains an assembly and study room and two recitation rooms. The apparatus and other equipment for the work in physics, chemistry, and natural history are exceptionally good for a small high school. There is also a good library and a reading room with current newspapers and magazines.

The expense of running the school in 1903–4 was $9,588, including $4,430 for teachers' salaries and $5,158 for buildings, grounds, and incidentals. This was a year when considerable sums were spent for furniture, apparatus, supplies, and additional land. The running expenses for the first six months in 1905 were $3,775. Heretofore five teachers have been employed, but this year there are six.

Previous to this year the Norton County High School has offered college preparatory, normal, business, and general science courses, but no courses related in any direct way to the leading industry of the county—farming. The county superintendent of schools said that his attention had been forcibly directed to this lack in the curriculum of the high school by the experience of a young man who came to the school from one of the many large farms in the vicinity, took the four-year business course, spent one year in a local bank at $30 a month, and then concluded that he would gain in both purse and pleasure by going back to the farm. Such a young man, and there are many like him in the Norton County High School, would have welcomed an agricultural course, and would have gone back to the farm much better prepared for the duties of life than he was with a business training. So the county superintendent of schools and the other members of the board of trustees decided that an agricultural course should take the place

FIG. 1.—PLANT-LIFE CLASS AT THE WATERFORD, PA., HIGH SCHOOL.

FIG. 2.—CLASS IN LIVE STOCK JUDGING DAIRY COWS AT THE WATERFORD, PA., HIGH SCHOOL.

FIG. 1.—CLASS IN LIVE STOCK STUDYING SHEEP ON A FARM NEAR WATERFORD, PA.

FIG. 2.—WATERFORD HIGH SCHOOL CLASS IN LIVE STOCK EXAMINING A HAMBLETONIAN MARE.

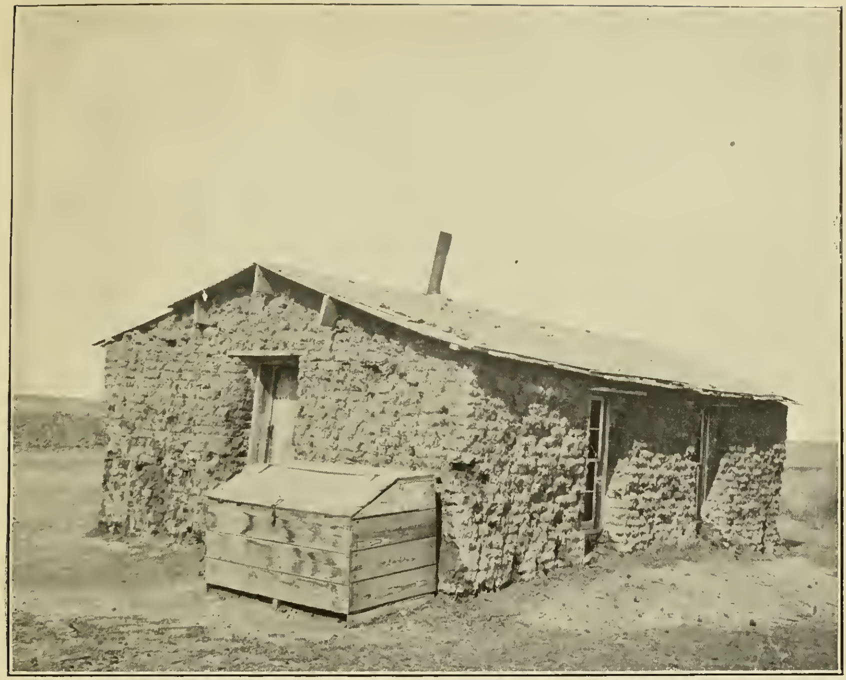

FIG. 1.—THE LAST SOD SCHOOL HOUSE IN NORTON COUNTY, KANS.

FIG. 2.—COUNTY HIGH SCHOOL BUILDING, NORTON, KANS.

of the general science course, and hired a graduate of the Kansas State Agricultural College to teach agriculture and other sciences in the high school. The Secretary of Agriculture, while making a trip through the "short-grass country," learned of the enterprise, became much interested in it, and in response to an appeal for aid sent a representative of the Office of Experiment Stations to Norton to help start it. The president of the Kansas State Agricultural College also responded to a call for assistance and made one of a party of four that toured the county for eight days in the interests of the new course of study. As a result, considerable interest was aroused in the proposed new work, a tentative agricultural course was outlined, and arrangements were made with the three farm implement dealers of the town to open their warehouses to the classes in agriculture and furnish experts to give instruction on the mechanics, care, and use of farm machinery.

The agricultural work of the course will include botany, with special reference to variation, development of species, hybridization, and the influence of light, heat, moisture, etc., on the plant; soils and tillage; plant physiology, farm crops, grain judging, and horticulture; farm accounts; farm management, including farm plans, methods of cropping, farm machinery and its care, and rural economics with special reference to the problems of a business nature that will be met on the farm; animal production and stock judging, and dairying. The teacher of agriculture reports that the implement dealers have given further evidence of their interest in the agricultural course by offering prizes aggregating $112 in value for a grain-judging contest, open to all young men in the county, and that these prizes have been supplemented by a $15 suit of clothes from a clothing dealer. Continuing, he says: "I am well pleased with the way the boys take hold of the work. Out of 70 boys we have 9 enrolled in the agricultural course, and I think most of the first-year boys will take it up when they get to it in the course. It is proving popular in the school and entirely free from the prejudice I had anticipated at the outset."

This is the nucleus of an important experiment in education. Norton is just in the edge of the great semiarid region of the Middle West. Agricultural practice in that region differs materially from that of the more humid regions on the one hand and from that of the irrigated districts on the other. The teacher of agriculture is thoroughly familiar with the agriculture of the region, and has but recently graduated from an agricultural college which is devoting much study to the problems of the hundredth meridian belt. The agriculture of this belt is extensive. Here one man works as much land as four or five men in the East; he cultivates three rows of corn at one crossing of the field, and does other things on an equally extensive scale. Improved farm machinery makes this method of farming possible. It

is therefore of the greatest importance that much attention to farm machinery be given in the agricultural course at the Norton County High School. The cereals (corn and wheat) are the leading field crops, hence the importance of grain-judging contests and other school work relating to these great staples.

The county superintendent of schools has expressed the hope that the school may also do much work that will be of immediate practical benefit to the agriculture of the county, such as testing seeds for viability, or germinating power (exercise 2), and milk and cream for butter fat; treating oats and wheat for smut and potatoes for scab; spraying trees and garden crops for insect pests and diseases, and making plans for farm buildings, roads, water systems, etc. Such work could be done largely by the pupils at school or on the different farms on Saturdays. It would be educational and at the same time would make the farmers feel that they were getting some immediate tangible return for the taxes paid in support of the school.

Exercise 2.—*Germination test of seeds.*

Count out 50 or 100 seeds of the kind to be tested[a] and place them in a plate between two folds of moistened canton flannel or thin blotting paper (fig. 73). On a slip of white paper record the variety, number of seeds, and the date, then place it on the edge of the plate. Cover the whole with another plate or a pane of glass to prevent too rapid evaporation of moisture. Set the plate in a warm room (68° to 86° F.) and examine the seeds every twenty-four hours for six or eight days.[b] If they get too dry add enough water to moisten, not saturate, the cloth or blotting paper. At the end of the test count the sprouted seeds and from them determine what percentage of the whole number of seeds are good. With large seeds no difficulty will be experienced in using the folds of canton flannel, but with small seeds the blotting paper is better.

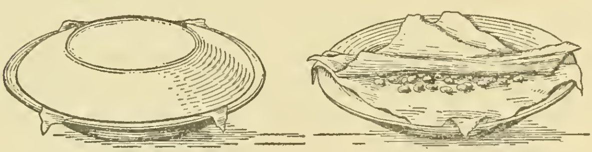

Fig. 73.—Seed-testing device.

Another seed tester (fig. 74) is made by inverting a small tin basin (*b*) in a larger basin (*a*) and covering the small basin with a piece of clean cloth large enough to dip into the water (*c*) at each end. Place seeds on the cloth and cover with another cloth as shown at *d*, *e*. How does moisture get to the seeds?

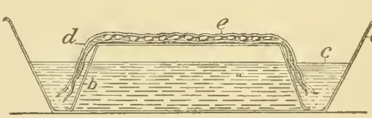


Fig. 74.—Another seed-testing device.

[a] In official germination tests 100 seeds are used of peas, beans, corn, and other seeds of similar size, and 200 seeds of clover, timothy, cabbage, wheat, and other small seeds.

[b] For most seeds six days are enough for the test, but beets, buckwheat, cotton, cowpeas, onions, redtop, tomatoes, and watermelons should be allowed to remain eight days; salsify and spinach ten days; carrots, celery, parsnips, and tobacco fourteen days, and bluegrass and parsley twenty-eight days.

## LABORATORY EXERCISES.

The schools just described are utilizing illustrative material in the best possible way. They are making use of the actual experiences and business of the communities. There is no make-believe about it. Some of the principles of agriculture, however, do not lend themselves so readily to illustration in this manner. There is need of some laboratory work which can best be performed indoors with specially prepared apparatus. But much of the material for this apparatus is so inexpensive and many of the exercises are so simple that even the untrained teacher in the one-room rural school need have no hesitation in undertaking such work.

### MATERIALS NEEDED.

Two dozen empty tomato cans, three or four lard pails, a few baking-powder cans and covers, a lot of empty bottles, a few small wooden boxes, a collection of typical soils (clay, sand, loam, and muck or peat), and a few seeds of garden and farm crops will enable the teacher and pupils to perform a variety of experiments illustrating important principles upon which the science and practice of agriculture are based, and will not cost a cent. If to this material the school board or the pupils will add by purchase an 8-ounce glass graduate (10 cents), 4 dairy thermometers (60 cents), 6 student-lamp chimneys (30 cents), 100 5-inch filter papers (15 cents), a pint glass funnel (10 cents), a 4-bottle Babcock milk tester with test bottles, pipette acid measure and acid ($5), an alcohol lamp (25 cents), a kitchen scale with dial which will weigh from 1 ounce to 24 pounds (90 cents), 12 ordinary glass tumblers (30 to 50 cents), a small quantity of litmus paper, and a few ordinary plates, pie tins, etc., the school will be provided with an excellent equipment for laboratory exercises, and all at a cost of less than $10.

### PHYSICAL CHARACTERISTICS OF SOILS.

With this material in the hands of the pupils and a teacher willing to experiment and learn with the pupils the ordinary rural schoolroom becomes a laboratory in which it is possible to determine the comparative temperature, weight, acidity, porosity (exercise 3), capillarity (exercise 4), and fertility of different soils; to test their water-holding capacity and the readiness with which they may be drained, and to show the effects of cultivation, mulching, and puddling on the moisture content and physical condition of different soils. As far as the training of the pupils in mathematics will permit, the results obtained in the laboratory exercises should be translated to field conditions, and the importance of the principles involved should be brought out by questions concerning their application to the practical operations of farming.

EXERCISE 3.—*Porosity—the capacity of soils to take in rainfall.*

Break the bottoms off 5 long-necked bottles,[a] tie a small piece of cheese cloth or thin muslin over the mouth of each and arrange them in a rack with a glass tumbler under each, as shown in figure 75. Fill the bottles to about the same height with different kinds of soil—gravel in one, sand in another, etc., and firm the soils by lifting the rack and jarring it down moderately three or four times. Now, with watch or clock at hand, and with a glass of water held as near as possible to the soil, pour water into one of the bottles just rapidly enough to keep the surface of the soil covered and note how long before it begins dropping into the tumbler below. Make a record of the time. Do likewise with each of the other bottles and compare results. Which soil takes in water most rapidly? Which is the most porous? What happens to the less porous soils when a heavy shower of rain comes? How can a soil be made more porous? Repeat the experiment with one of the soils, packing the soil tightly in one bottle and leaving it loose in the other. What is the effect of packing? Does this have any bearing on farm practice?

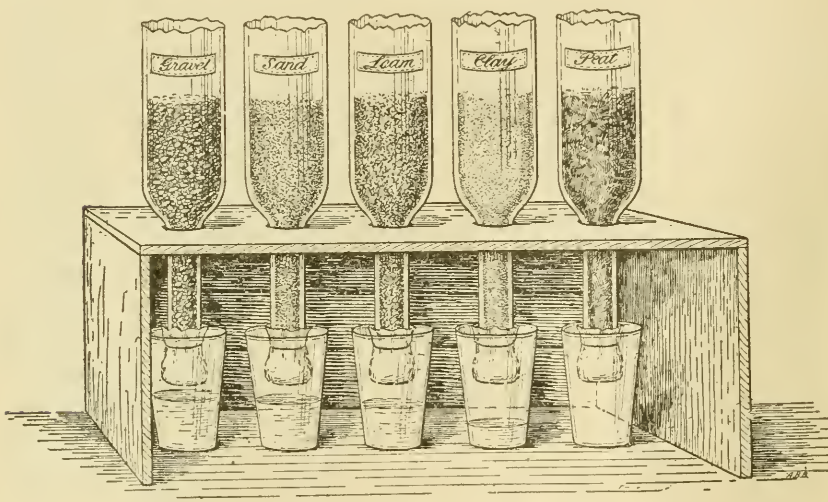


FIG. 75—Apparatus to test the capacity of soils to take in rainfall.

Which soil has the greatest capacity for water—that is, which could take in the heaviest shower? This can be determined from the above experiment by emptying and replacing each tumbler as soon as all free water has disappeared from the upper surface of the soil above it. After water has ceased dripping from all the bottles measure and compare the water in the different tumblers. Which soil continued dripping longest? Which would drain most readily?

Which soil would store up the greatest amount of moisture for the use of plants? This can be determined from the same experiment by weighing each bottle before and after filling it with dry soil, and again after water has entirely ceased dripping from it. The difference between the weight of the dry soil and that of the wet soil is the weight of water stored. During the time that the bottles are dripping, which may take several days, they should be covered to prevent evaporation of water from the surface of the soils.

Make other practical applications of the principles brought out in this exercise.

[a] To break the bottom off a bottle file a groove in the bottle parallel with the bottom. Heat a poker red hot and lay it in the groove. As soon as a small crack starts from the groove draw the poker around the bottle and the crack will follow.

EXERCISE 4.—*Capillarity—the power of soils to take up moisture from below.*

Arrange 4 or 5 student-lamp chimneys, as shown in figure 76, and tie cheese cloth or thin muslin over their lower ends. Fill each with a different kind of dry soil, as in exercise 3. Pour water into the pan beneath until it stands about half an inch above the lower end of the chimneys, then observe the rise of water in the different soils. Make notes on the height to which the water rises, and on the time it takes. In which soil does the water rise most rapidly; in which to the greatest height? Which soil draws up the greatest amount of water? How can this be determined? This power of soils to raise water from below is called capillarity. It is an important function, for by it plants are able to get moisture and plant food from the subsoil in times of drought.

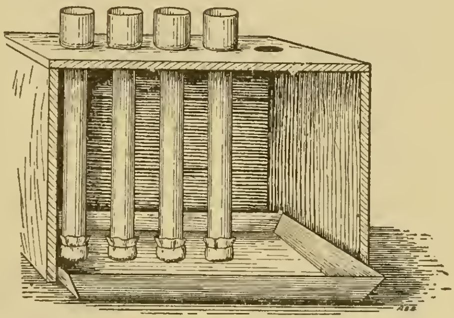

FIG. 76—Apparatus to test the power of soils to take up moisture from below.

If chimneys are not to be had, this experiment can be performed with the apparatus shown in figure 75 by substituting the pan for the tumblers; or the experiments performed with the bottles can be performed with the chimneys and tumblers.

If more accurate tests of capillarity are desired it will be necessary to procure a series of glass tubes at least 3 feet high, for in some soils water will rise to that height, or even higher.

RELATION OF SOILS TO PLANTS.

It will be perfectly feasible also to arrange exercises showing the relation of the physical characteristics of soils to plant growth—that plants need moisture in the soil; that they take up this moisture (exercise 5) and give off a part of it through their leaves (exercise 6); how much moisture is taken from the soil by a given plant; that too much moisture is injurious to plants; how the root hairs of plants absorb moisture; the best depth at which to plant different seeds in different soils (exercise 7); the effect of cultivation on plant growth, and a dozen other things important for the farmer to know and interesting as experiments for school children.

Seed testing has already been referred to. It is highly important that farmers should know that they plant good seed in order that all of the land they plow, plant, and cultivate may at least have a chance to make some return for the labor bestowed upon it. It is estimated that in the summer of 1905 the farmers of Iowa increased their corn crop several million bushels merely by giving better attention to the quality of seed planted. It would not be a difficult matter to teach every boy in school the process of testing seed, nor to impress upon him the practical importance of this work. Testing the viability of seeds would lead naturally to other studies in propagation, such as

making hard and soft cuttings, layering, grafting, and budding, all of which are clearly described in bulletins of this Department and in other publications which teachers can procure without cost.

EXERCISE 5.—*To show that plants absorb moisture from the soil.*

Thoroughly pulverize and sift enough good garden soil to fill two flower pots of the same size. To get the same amount of soil into each pot it should previously be weighed or carefully measured. Plant several kernels of corn in one pot, water both, and set them aside for the corn to grow. Whenever water is applied to the pot containing the corn an equal amount should be applied to the other pot, in order that both soils may be packed alike. When the corn is 2 or 3 inches high get two lard pails just large enough to take in the pots to their rims, as shown in figure 77. Mark on the outside of the pails the depth to which the pots will extend on the inside, and at a point 1 inch above each mark make a dent which can be distinctly seen on the inside of the pail. Now fill each pail with water up to the dent, water both pots thoroughly, and set them in the pails as shown in the figure. Set both pails and pots in a warm, light place so that the corn will continue to grow. The next day remove the pots, and you will probably find that the water is not up to the dents. What has become of it? From a previous experiment you will probably conclude that the soil has taken it up. From an 8-ounce graduate pour into one pail just enough water to bring it up to the dent again. Make a record of the amount necessary to do this. Fill the graduate and bring the water in the other pail up to the dent. Again record the amount of water used. Repeat these operations daily for two or three weeks. Find the total amount of water added to each pail. You will probably find that the pot containing the corn has taken up considerably more water than the other pot. Why? Was there any place for the water to escape except through the soil and the corn? How much water did the corn use? What became of this water? The next exercise will show what became of a part of it.

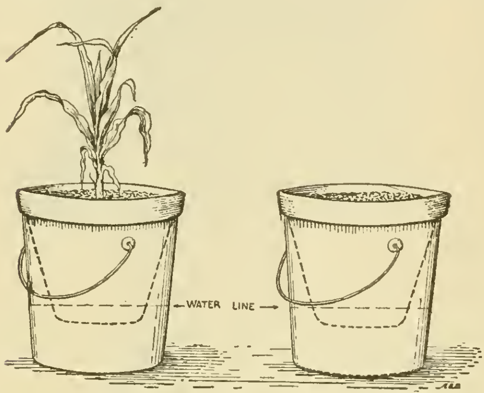


FIG. 77.—To show that plants absorb moisture from the soil.

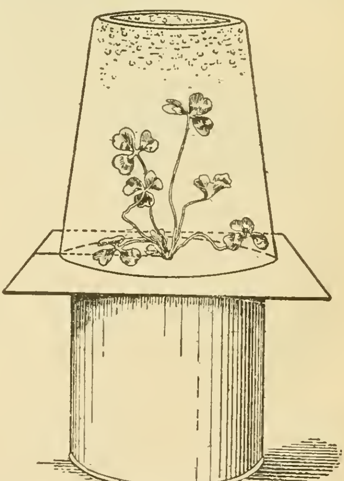

FIG. 78.—To show that plants give off a part of the moisture absorbed from the soil.

EXERCISE 6.—*To show that plants give off moisture.*

Take a plant that is well started in a tomato can or flower pot, a piece of cardboard, and a glass tumbler or jar large enough to cover the plant. Cut a slit in the cardboard and draw it around the plant as shown in figure 78. Seal the slit with pitch, wax, or tallow so that no moisture can come up through it from below; cover the plant with the glass and set it in a warm, sunny place. Moisture will condense on the inner surface of the glass. Where does it come from? Is all the moisture absorbed by the roots given off in this way? How can you find out? Why do plants need water?

EXERCISE 7.—*Depth of planting.*

To determine the best depth at which to plant corn take an olive bottle about 8 inches high, or other similar glass vessel. Fill it with garden soil to a height of 5 or 6 inches from the top, put in a kernel of corn flat against the side of the bottle, put in another inch of soil, then another kernel of corn, and so on until the bottle is full, arranging the kernels spirally as shown in figure 79. Moisten the soil, wrap the bottle up to the neck in black paper or cloth, and set it in a warm place. Prepare other bottles in the same way, but plant in them beans, peas, and some small seeds, such as those of radishes, onions, and lettuce. By taking off the wrappings and looking at the seeds daily you can not only determine the best depth at which to plant different seeds, but make many interesting observations regarding the rate of germination, how the little plants push out of the ground, whether they take the seeds up with them or leave them behind, etc. Take careful notes and try to determine whether large or small seeds should be planted deeper, whether the roots or the little plants are formed first, whether the plants ever start down or the roots up.

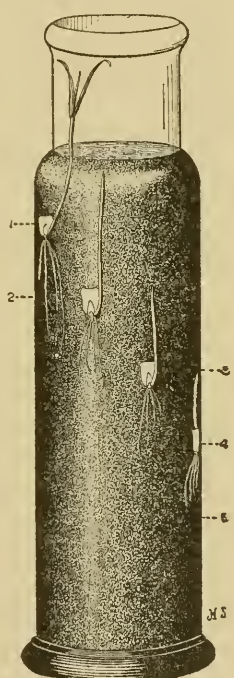

FIG. 79.—To show the best depth at which to plant corn.

STUDIES OF MILK.

The extent to which milk enters into the regular diet of a large percentage of the inhabitants of both urban and rural communities renders it almost imperative that some instruction concerning the importance of sanitary methods of handling milk be given in the public schools. In rural districts a number of inexpensive and simple experiments could be arranged to show the effect of different methods of milking, cooling, aerating, bottling, shipping, and other processes in the handling of milk upon its purity, flavor, odor, and keeping qualities (exercise 8). If the school is provided with a Babcock milk tester, the pupils could determine the relative value of different cows for the production of cream and butter, also the relative efficiency of different methods of separating cream from the rest of the milk.

EXERCISE 8.—*To show the effect of cleanliness on the keeping quality of milk.*

Provide one of the boys with two pint bottles which have been cleaned thoroughly, scalded, and plugged with clean cotton batting (absorbent cotton is better), and instruct him as follows: Take the bottles home and at milking time select a cow which has stood in the stable several hours and has not been cleaned. Milk a quart or two of milk into a pail in the usual way and set it aside. Then clean the sides and udder of the cow by first brushing and then wiping with a damp cloth. Wash the hands thoroughly, remove the cotton plug from one of the bottles, fill the bottle to the neck by milking directly into it, and immediately replace the cotton plug. Mark this bottle A. Now carry the milk in the pail to the milk room, strain it in the usual way, and from it fill the other bottle, removing and replacing the cotton plug as before. Mark this bottle B. Set both bottles over night in the room where the milk is usually kept, and the next morning bring them to school. Remove the plugs and note whether any bad odor has developed in either bottle. Pour a small quantity of milk out of each bottle and replace the plugs. Taste the samples. Is there any bad flavor? Test them with litmus paper to see if either is getting sour. Set the bottles in a moderately cool place, and examine them as above, morning and evening, for several days, making notes on any changes that take place in either. Does cleanliness have any effect on odor? On flavor? On acid formation?

Repeat this experiment, cooling bottle A immediately after filling and treating B as before. Does cooling affect the keeping quality of milk?

By keeping accurate temperature records and careful notes on changes occurring under different conditions, the above exercise may be made to yield quite accurate data regarding the proper methods of handling milk.

## AGRICULTURE AN AID TO OTHER SCHOOL WORK.

Agriculture taught in this way, that is, supplemented and illustrated by numerous outdoor observations and laboratory exercises, will prove not only an interesting and instructive study in itself, but also an aid in teaching other subjects. What more efficient method of enforcing and fixing in the minds of the pupils the fundamental operations in arithmetic than by the frequent use of these operations in solving problems in their everyday life and work? The tables of weights and measures will be in constant use and the principles of percentage and proportion will enter into the solution of nearly every problem in soils. Composition will lose some of its bad flavor, and spelling be no longer distasteful when applied to the description of experiments in which the pupils are interested. Manual training will find its place in the making of boxes, labels, farm-levels, and other appliances used in the experiments. Some of the principles of botany, physics, and chemistry will be learned and applied in the experiments with soils, plants, and milk. And all of the work will leave a more lasting impression because concrete; more interesting because connected with the life and occupation of the pupils.

An educator who has had nearly five years' experience teaching in ungraded rural schools relates that as he now looks back upon that experience the nearest approach to satisfaction that he can feel is in

contemplation of a winter term's work in a country school having an enrollment of about 65 pupils, ranging in age from 5 to 20 years. He conducted between 25 and 30 recitations a day, played with the pupils during recess, drilled a company of boys in military tactics at noon, and yet found time nearly every day for a simple experiment or demonstration in physics or chemistry. Neither of these subjects was taught regularly in the school, but the exercises were introduced to illustrate the principles governing some of the common elements, such as oxygen, hydrogen, nitrogen, phosphorus, and potassium, in some of the combinations in which they are found in water, pure air and foul, plant and animal tissue, and other things affecting the everyday life and experience of the pupils. Teacher and pupils extinguished lighted candles by pouring carbon dioxid over them, made hydrogen guns, burned picture wire in oxygen, and performed other experiments which not only were interesting enough to make the teacher forget his troubles and the pupils their mischief-making, but made lasting impressions concerning the principles illustrated. The teacher was recently told by two of his former pupils that the one feature of school work that winter which they recalled clearly was the "experiments."

That was fourteen years ago, when educators in the North Central States were giving little heed to the needs of the rural schools. The teacher had spent two and a half years in an agricultural college, but had never heard or dreamed of such a thing as teaching agriculture in country schools. There were no elementary text-books of agriculture, no bulletins containing laboratory exercises carefully prepared for the use of country teachers, no normal schools where teachers could be trained in country-life subjects, no encouraging words from school superintendents, teachers' journals, or even the agricultural press.

Now a wonderful change has come over the aspect of country life and over the attitude of educators toward rural education. The State superintendents of schools consider it their highest duty to minister to the welfare and progress of the rural schools; State legislatures are providing special normal schools for country teachers; the older normal schools are offering courses in country-life subjects; the State agricultural colleges are aiding the normal schools by giving short courses for teachers, and their experts are preparing text-books, bulletins, and other reading matter on nature study and agriculture for the rural schools; teachers' associations and farmers' organizations are giving much discussion to these matters, and the school journals and agricultural papers are almost unanimous in their support of the movement for better rural schools and more instruction related to the environment of the pupils in these schools. With such encouragement and such assistance no teacher imbued with the spirit of progress, who is willing to do a little more than the contract calls for, and who is brave

enough to say to the pupils, "I don't know, but I'll work with you to find out," need have any hesitation about undertaking some features of the work alluded to in this article. Such teachers may feel assured that their efforts will not be passed over without recognition. There may be no immediate call to "come up higher," though intelligent and unselfish devotion to study is seldom without its pecuniary reward; but there will be a never-failing reward in feeling and knowing that better work has been done in preparing the children to meet the duties of life.

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